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Differences in Functional and Pain-related Outcomes for Patients Following Total Hip Arthroplasty Performed Using a Posterior versus Anterior Approach

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Differences in Functional and Pain-related Outcomes for Patients Following Total Hip Arthroplasty Performed Using a Posterior versus Anterior Approach

Disciplines

Physical Therapy

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CRITICALLY APPRAISED TOPIC -TREATMENT-

Title: Differences in Functional and Pain-related Outcomes for Patients Following Total Hip Arthroplasty Performed Using a Posterior versus Anterior Approach.

Clinical Scenario: One of the patients I worked with in the hospital was a 72 year old female with a diagnosis of left hip osteoarthritis, status post total hip arthroplasty (THA) performed via the posterior approach. She was very concerned about following her posterior hip precautions, afraid she might dislocate her hip. This fear translated into a fear of getting up and engaging in physical therapy, as I worked with her on transfers, gait training, and stair training over the course of her three day admission. I wondered if her functional outcomes would be better if her operation had been performed with a different approach and less restrictive precautions.

Brief Introduction: For the purposes of my clinical question, I want to know what the research says about the use of the posterior approach versus the anterior approach of total hip arthroplasty on patients with hip osteoarthritis. I am working in an acute care setting, and have been treating multiple post-operative THA patients. One of the orthopedic surgeons at the hospital performs most of his THAs using the posterior approach, requiring implementation of posterior hip precautions after surgery (no hip flexion $>90^\circ$, no adduction past midline, and no internal rotation). The other surgeon often uses the newer direct anterior approach, implementing only one precaution (no active straight leg raise). Although I am not a surgeon and cannot decide which approach to use on my patients, I would like to know which approach results in better outcomes in order to best guide my patients in their early post-operative rehabilitation, as well as to make appropriate recommendations to my patients in the outpatient setting who anticipate having a THA.

My Clinical Question: Which THA surgical approach, posterior or anterior, results in better early and long-term pain-related and functional outcomes for the patient with hip osteoarthritis?

Clinical Question PICO:

Population – Age 30-90, patients diagnosed with hip osteoarthritis/degenerative joint disease resulting in total hip arthroplasty

Intervention – THA performed via posterior approach, with posterior hip precautions implemented post-operatively

Comparison – THA performed via anterior approaches (direct anterior or anterolateral)

Outcome Measures – standardized functional outcome tools such as Harris Hip Score (HHS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Oxford Hip Score (OHS), and pain outcome measured by Visual Analogue Scale (VAS) or Numeric Pain Rating Scale (NPRS)

Overall Clinical Bottom Line: Based on the results of the outcomes from Barrett *et al.*, Rodriguez *et al.*, Yang *et al.* and Taunton *et al.*, limited evidence suggests that anterior approach THA may result in better early functional outcomes and pain level than posterior approach THA. The internal validity of the studies was fair to good, with the most significant threats being lack of randomization in one study, failure to account for study losses, and extraneous variables due to lack of strict protocol in several of the studies. Unfortunately, it is difficult to generalize the results of these studies to a broad patient population, as there were only six surgeons who were involved in performing surgeries in these four studies. Additional research should be performed with multiple facilities and surgeons involved and a strict protocol used throughout long-term follow up.

Search Terms: total hip arthroplasty, posterior approach, anterior approach, direct anterior approach, total hip replacement

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Rationale for Chosen Articles

To find the articles, I searched PubMed, EBSCO Host, Clinical Key, and CINAHL, using the above listed search terms and limiting my search to clinical trials published in the English language, within the past ten years. I found numerous articles that compared different THA approaches, and excluded the ones that focused on minimally-invasive versus conventional, or compared the lateral approach to a different approach. I also eliminated several studies that were performed in different countries and seemed to follow different procedures, including length of hospital stay and type of rehabilitation, than those in the U.S. Unfortunately, many of the articles I found were not randomized, which is understandable considering that a THA is a significant procedure, and researchers are showing respect for the patient and surgeon's desired approach in each individual case. Several randomized controlled trials are currently underway comparing the anterior and posterior THA approaches, but they have not yet been published.

- (1) **Barrett, WP, Turner, SE, Leopold, JP. Prospective Randomized Study of Direct Anterior vs. Postero-Lateral Approach for Total Hip Arthroplasty. *The Journal of Arthroplasty* 2013; 28(9):1634-1638.**

PEDro Score 6/10

Population - Included patients who were similar to my patient; they met criterion to require THA for non-inflammatory degenerative joint disease; average age for the two groups was 61.4 years for the direct anterior group and 63.2 for the posterior group

Intervention - Direct anterior approach THA surgical procedure without post-operative ROM restrictions

Comparison - Posterior approach THA surgical procedure with post-operative ROM restrictions

Outcome measures - Stair climbing, walking, radiographs, HHS, Hip Disability and Arthritis Outcomes Score (HOOS), VAS pain score, and 6-minute walk test (6MWT)

- (2) **Rodriguez, JA, Deshmukh, AJ, Rathod, PA, Greiz, ML, Deshmane, PP, Hepinstall, MS, Ranawat, AS. Does the Direct Anterior Approach in THA Offer Faster Rehabilitation and Comparable Safety to the Posterior Approach? *Clinical Orthopaedics and Related Research* 2014; 472:455-463.**

PEDro Score 4/10

Population - Included patients who were fairly similar to my patient; they were of age 25-75 with a diagnosis of unilateral hip osteoarthritis

Intervention - Direct anterior approach THA surgical procedure without post-operative hip precautions

Comparison - Posterior approach THA surgical procedure with post-operative hip precautions

Outcome measures - motor component of Functional Independence Measure (M-FIM), Timed Up and Go (TUG), VAS pain scale, HHS, UCLA activity score, Short Form 12-item Survey (SF-12), radiographs, length of hospital stay, narcotic consumption, discharge disposition, operative time, intraoperative and postoperative complications, reoperation frequency

- (3) Yang, C, Zhu, Q, Han, Y, Zhu, J, Wang, H, Cong, R, Zhang, D. Minimally-invasive total hip arthroplasty will improve early postoperative outcomes: a prospective, randomized, controlled trial. *Irish Journal of Medical Science*, 2010; 179:285-290.

PEDro Score 9/10

Population - Included patients who were fairly similar to my patient, but did include patients with femoral neck fracture, osteonecrosis and RA as well as OA.

Intervention - Minimally invasive anterolateral (Orthopädische Chirurgie München, OCM) approach THA surgical procedure

Comparison - Posterolateral approach THA surgical procedure

Outcome measures - HHS, Barthel index questionnaire, VAS pain scale, operation time, incision length, blood loss, blood transfusion, radiograph analysis, incidence of complications

- (4) Taunton, MJ, Mason, JB, Odum, SM, Springer, BD. Direct Anterior Total Hip Arthroplasty Yields More Voluntary Cessation of All Walking Aids: A Prospective, Randomized Clinical Trial. *The Journal of Arthroplasty*, 2014; 29(9):169-172.

PEDro Score 6/10

Population - Included patients who were similar to my patient; ages 25-80 with diagnosis of degenerative arthritis of the hip (excluded those with other diagnoses)

Intervention - Direct anterior approach THA surgical procedure with no post-surgical ROM restrictions

Comparison - Mini-posterior approach THA surgical procedure with post-surgical ROM restrictions

Outcome measures - Radiographs, time until attainment of functional outcomes, SF-12, WOMAC, HHS

Table 1. Comparison of PEDro Scores

	Barrett <i>et al.</i>	Rodriguez <i>et al.</i>	Yang <i>et al.</i>	Taunton <i>et al.</i>
Random	yes	no	yes	yes
Concealed allocation	yes	no	yes	no
Baseline comparability	yes	yes	yes	yes
Blind Subjects	no	no	yes	no
Blind Therapists	no	no	yes	no
Blind Assessors	partially	no	yes	partially
Adequate Follow-up	yes	yes	yes	yes
Intention-to-Treat	no	no	no	yes
Between Group	yes	yes	yes	yes
Point Estimates & Variability	yes	yes	yes	yes
Total Score	6/10	4/10	9/10	6/10

Based on the above comparisons, I have chosen to write this critically appraised paper on the studies published by Barrett *et al.*, Rodriguez *et al.*, Yang *et al.* and Taunton *et al.* as a means to answer my clinical question. Each of the studies involved two groups of subjects who received different surgical approaches for a total hip arthroplasty, anterior or anterolateral, and posterior or posterolateral. Each of the studies used standardized functional outcome tools that gave self-reported data on pain and function. Subjects were followed for at least a year after surgery in each of these studies. All of the studies were published within the past five years. In spite of validity concerns that will be discussed for each article, the four articles chosen were helpful in answering my clinical question.

Article: Barrett *et al.*, 2013.

Clinical Bottom Line:

Based on this randomized, controlled trial performed by Barrett *et al.*, there is moderate evidence to support the direct anterior approach to total hip arthroplasty as providing better early pain and functional outcomes than the posterior approach in patients with non-inflammatory degenerative joint disease. Although rehabilitation protocol was not well described by the authors, the posterior approach group received post-operative range of motion restrictions that are likely similar to those implemented for my patients. Not only did the direct anterior group avoid having any precautions, they also had a lower pain rating on the VAS scale the day after surgery, with a medium effect size, and a higher functional score on the HHS at six weeks post-operatively, with a large effect size. Both groups made significant improvements in pain and function throughout their first year after surgery. The internal validity of this study is fair, since extraneous variables were not controlled for during the follow up year after surgery, study losses were not accounted for, and no blinding was performed, allowing for bias. External validity is also fair, as this study included only patients at one facility and all surgeries were performed by the same surgeon. In spite of validity concerns, the early post-operative benefits of receiving a direct anterior approach THA do outweigh the costs, and I would recommend that my patients seek out this approach when possible.

Article PICO:

Population— patients diagnosed with non-inflammatory degenerative joint disease with indication for THA

Intervention— Direct anterior approach THA, with no post-operative restrictions in range of motion

Comparison— Posterior, or postero-lateral, approach THA, with post-operative range of motion restrictions

Outcomes— Stair climbing, walking, radiographs, HHS, Hip Disability and Arthritis Outcomes Score (HOOS), VAS, and 6MWT

Blinding: Subjects, surgeons, and therapists were not blinded. Assessors of radiographic outcomes were blinded, but assessors of other outcome measures were not blinded. The lack of blinding does pose several threats to the internal validity of the study. Some subjects may have gone into surgery with the expectation that one surgical approach was better than the other. Rater bias could have also influenced the outcomes, in particular the functional measures, since the assessors were not blinded. It is less likely that assessors influenced subjects' answers on the self-reported questionnaires. Because surgeons and therapists were not blinded, they could have had an influence on subjects' post-operative success based on their expectations of which group would perform better. This is a significant threat to the study's internal validity.

Controls: There was not a true control group in this study; rather, both groups received surgical treatment. All subjects from both groups received the same prosthetic implants, with small variations in femoral head size. The same treatment protocols were used pre-operatively as well as post-operatively, with the one exception being implementation of posterior hip precautions for the postero-lateral approach group. Because of this standardization between groups, it is likely that between group differences can be attributed to the intervention.

Randomization: Subjects were randomized into one of two groups, with mostly similar baseline demographics attained between groups. The direct anterior approach group did have a significantly larger number of males than the posterior approach group, and scored significantly higher on the pain portion of the HHS questionnaire prior to surgery. The authors state, however, that an analysis controlling for these differences did not have an influence on the between-group differences post-operatively. Therefore, the randomization is considered successful.

Study: This randomized, controlled trial involved 87 subjects, 43 who underwent a direct anterior approach THA and 44 a posterior (or, postero-lateral) approach THA. All subjects had a diagnosis of non-inflammatory degenerative joint disease, with indication

for THA, and met exclusion and inclusion criteria that are not specifically stated by the authors. Although an age range is not reported, the average age of subjects in the direct anterior approach group was 61.4 years and 63.2 years in the posterior approach group.

All surgeries were performed by a single surgeon who had previous experience performing both surgical approaches, but more experience with posterior. The anterior approach was performed with the patient supine on a modern fracture table, with the 10-14 cm incision made between the muscular planes anteriorly. A C-arm x-ray machine was used throughout the procedure to aid in appropriate positioning of the prosthetic devices after removal of the femoral head and reaming of the acetabulum. Subjects who received the posterior approach THA were placed in the lateral decubitus position on a standard OR table, with a 10-14 cm incision over the posterior-lateral area of the hip and incision of the gluteus maximus, external rotators, and posterior capsule to access the hip joint. Similar prosthetic components were fitted and used for this surgical technique.

Post-operatively, both groups participated in early rehabilitation, which was not well described, with unspecified range of motion restrictions implemented for those who had a posterior approach THA.

Outcome measures: The outcome measures that are relevant to my clinical question are the HHS, HOOS, and VAS. The HHS was assessed pre-operatively, and both the HHS and HOOS were measured at 6 weeks, 3 months, 6 months, and 12 months post-operatively. The VAS was assessed pre-operatively, post-operatively on the day of surgery, on each of the first two days post-surgery, and at each of the other post-operative times mentioned above.

The authors do not state who the assessors were or what their reliability was in outcome assessments; however, previous studies have shown all three of these scales to be valid and reliable (Kaczmarek *et al.*). The HOOS includes five subsections, with the two most relevant being pain and function in daily living. Each section is scored 0-100 with 100 indicating no problems. The established minimal clinically important difference (MCID) for the pain section is 24, according to published literature, with no established MCID for the function of daily living section alone (Paulsen *et al.*). The HHS is a 100-point scale that assesses hip joint pain, function, range of motion, and absence of deformity, with a higher score indicating better function. It has a MCID of seven points (Achten *et al.*). The VAS is a zero to ten scale of self-reported pain. It has an MCID of 15.3 mm on a 100 mm scale in patients with hip OA (Tubach *et al.*). This is equivalent to an MCID of 1.53 cm on the ten centimeter scale used by the authors of this study.

Study losses: The authors did not discuss study losses, and it is difficult to tell from the data presented whether all subjects are accounted for. An intention-to-treat analysis was not performed. It does seem, however, that all subjects were analyzed in the groups they were randomized to (it would not have been possible for a subject to change groups after undergoing the surgical procedure that was designated to him or her).

Summary of internal validity: The internal validity of this study is fair. Strengths of the study's validity include randomization of subjects, an appropriate comparison group, use of valid and reliable outcome measures, use of appropriate statistical tests, and performance of a power analysis with an adequate sample size recruited. However, there are two major threats and three minor threats to the internal validity. Extraneous variables are a major threat because the protocol for post-surgical rehabilitation was not well described. It is unclear whether subjects were referred to outpatient physical therapy after discharge from the hospital and whether they were allowed to seek out further treatment for hip pain in the 12 months after surgery, implying that some patients may have received more treatment/therapy than others. The second major threat is the failure to address study losses or perform an intention to treat analysis. It is not stated whether any subjects dropped out and how this was managed by the researchers in their data analysis. Rater bias, Hawthorne effect, and Rosenthal effect are minor threats to validity. Those who administered the outcome measures were not blinded and could have had an influence on the results. Hawthorne and Rosenthal effects are a concern due to the lack of subject blinding; subjects may have had an increased motivation level because they knew they were part of a study.

Evidence: Scores from the HHS and HOOS measured at six weeks and 12 months post-operatively were taken from data presented in the study and analyzed in order to address my clinical question. VAS scores taken on the day of the operation and at post-operative days one and two were also analyzed along with 6 week and 12 month measurements. These are presented in Table 2.

Table 2. Between group comparison of Visual Analogue Scale means and standard deviations (SD), measured post-operatively on the day of surgery, day one, day two, 6 weeks, and 12 months.

	Day of surgery	Day 1	Day 2	6 weeks	12 months
Direct anterior approach	4.2 (1.4)	4.0 (1.0)	3.8 (1.1)	1.9 (1.2)	1.6 (1.4)
Posterior approach	4.6 (1.8)	4.5 (1.2)	4.1 (1.0)	1.9 (1.6)	1.3 (0.6)
Between group difference (p value)	0.2257	0.0472	0.2042	0.9530	0.1857

There was a significant difference between groups on the first day after surgery, favoring the direct anterior group ($p=0.0472$). Based on the means and standard deviations provided by the authors and presented in Table 2, effect size was calculated and is presented in Table 3.

Table 3. Effect size and 95% confidence intervals (CI) for VAS measures in direct anterior approach and posterior approach THA over time.

	Day of surgery	Day 1	Day 2	6 weeks	12 months
Effect size	0.25 (-0.17 to 0.67)	0.50 (0.03 to 0.88)	0.27 (-0.14 to 0.71)	0 (-0.42 to 0.42)	0.21 (-0.14 to 0.70)

The effect size of 0.50 on the day after surgery demonstrates a moderate effect of decreased pain in the direct anterior group in comparison with the posterior group. The CI indicates that this number would vary from being very small to very large if the study

were repeated multiple times. Effect sizes listed at other time points are irrelevant, as the CIs cross zero and the results could favor either group if the study were repeated.

Both groups made a clinically important improvement from surgery day to six weeks post-operative, on average, meeting the MCID of a decrease in greater than 1.53.

Table 4. Between group differences in Harris Hip Score means and SDs taken pre-operatively as well as at six weeks and 12 months post-operatively.

	Pre-operative	6 weeks	12 months
Direct anterior approach	57.6 (10.2)	89.5 (8.1)	97.5 (5.7)
Posterior approach	55.1 (9.1)	81.4 (9.8)	97.3 (5.5)
Between group difference (p-value)	0.2464	0.0001	0.8700

The only significant between-group difference was noted at six weeks after surgery, with a p-value <0.05. After one year, however, there is no significant effect on functional differences between groups. This could be due to a ceiling effect, as both groups approach the maximum score of 100 after 12 months. These data were used to calculate effect size post-operatively, which is presented in Table 5.

Table 5. Effect size and 95% confidence intervals for HHS measures in direct anterior approach and posterior approach THA at six weeks and 12 months post-operative.

	6 weeks	12 months
Effect size	0.9 (0.46 to 1.34)	0.4 (-0.38 to 0.46)

Six weeks after surgery, a large effect size of 0.9 favors the direct anterior approach over the posterior approach in terms of function as based on the total Harris Hip Score. The direct anterior approach THA may result in earlier functional improvements, although long term functional recovery does not differ between surgical approaches, as indicated by 12 month data.

Both groups make clinically important improvements from baseline to six weeks after surgery, and then again from six weeks to 12 months, exceeding the MCID of seven points.

Table 6 presents outcomes from the pain subsection of the HOOS, as reported by the authors.

Table 6. Between group differences in Hip Disability and Arthritis Outcomes Score pain section means and SDs at six weeks and 12 months post-operative.

	6 weeks	12 months
Direct anterior approach	83.5 (14.7)	94.3 (12.7)
Posterior approach	79.5 (16.7)	93.4 (10.6)
Between group difference (p-value)	0.2673	0.7407

There was no significant difference between groups at either time point, as indicated by the listed p-values.

Within group analysis reveals that neither group met the MCID of 24 points for clinically important change between these two time points; however, both groups approach the maximum score of 100, indicating a potential for ceiling effect. Baseline HOOS scores prior to surgery were not measured, so we are unable to state whether each group made a clinically important change from baseline to these follow up points.

Data from the HOOS functional subsection, as reported by the authors, are presented in Table 7.

Table 7. Between group differences in Hip Disability and Arthritis Outcomes Score function in daily living section means and SDs at six weeks and 12 months post-operative.

	6 weeks	12 months
Direct anterior approach	83.5 (13.7)	94.4 (11.2)
Posterior approach	79.0 (13.3)	95.4 (7.3)
Between group difference (p-value)	0.1341	0.6518

No significant difference was found between groups in functional differences post-operatively, as measured by the HOOS.

No MCID exists for this subsection, so no conclusion can be made about clinically important differences within groups.

In conclusion, there is weak evidence to favor the direct anterior approach in improved pain levels the day after surgery (effect size = 0.50) and improved functional outcomes in the first six weeks after surgery (effect size = 0.90). Both surgical approaches tend to result in similar long term outcomes.

Applicability of study results:

Benefits vs. Costs:

The benefits of receiving THA via the direct anterior approach over the posterior approach are not extensive, but include earlier functional gains and lower pain level after surgery, according to this study. Length of hospital stay was also shorter, which could be a significant financial benefit for the patient.

The costs of having a direct anterior approach THA include a longer surgery time with more significant blood loss on average. The incision was also one centimeter longer, on average. Complications occurred in both groups, with no significant difference between groups in number of complications. One subject in the posterior group did have a revision due to recurrent dislocation, whereas no subjects in the direct anterior group had this complication. The early benefits of choosing a direct anterior approach THA over the posterior approach seem to outweigh the costs.

Feasibility of treatment:

The direct anterior approach THA is a newer technique and not as readily available as the posterior approach THA. Extensive training is required for a surgeon to become

proficient in the direct anterior approach. Both surgical approaches are well described in the literature, with similar protocols used between surgeons. In terms of post-operative feasibility, posterior approach range of motion restrictions can be difficult for patients to implement. Because one subject from the posterior approach group did have recurrent dislocation, this amplifies the importance of following the precautions. In this regard, post-operative rehabilitation protocol is more feasible for those with direct anterior approach THA, because they do not have range of motion precautions to follow.

Summary of external validity: The external validity of this study is fair, due to a poor description of the population, and the previously discussed threats to the internal validity. Because the inclusion and exclusion criteria were not given in detail, it is difficult to determine if the subjects in this study are similar to the patients I see in the hospital or clinic, although the diagnosis and average age of the subjects do match well with my patients. Because the study was performed at a single institution and all surgeries were performed by a single surgeon, it is difficult to extrapolate the study results to a wider population.

Article: Rodriguez *et al.*, 2014.

Clinical Bottom Line:

Based on evidence from this prospective, comparative, non-randomized study by Rodriguez *et al.*, patients with unilateral osteoarthrosis (osteoarthritis) of the hip will have similar improvements in pain and function after a total hip arthroplasty performed via the direct anterior approach or the traditional posterior approach. Results from the HHS outcome measure found that subjects who underwent either procedure made significant improvements during the first year after surgery. Pain level, measured using the VAS, was similar between groups two days after surgery. The two groups were treated with a similar rehabilitation protocols after surgery; however, post-operative range of motion restrictions were implemented for subjects in the posterior group. The internal validity of this study is fair, with some controls used, but several threats present due to lack of randomization (subjects may have had inherent differences based on the type of subject who chose each group), lack of blinding (rater bias may have influenced subjects' responses), and several other minor threats. Many patients were excluded from involvement in this study, limiting my ability to generalize the results to all of my patients. Although a cost-benefit analysis does not favor one approach over the other, the anterior approach allows the patient to return to normal activities without range of motion restrictions. Therefore, I am likely to recommend this anterior approach to my patients, even though they may achieve similar pain and functional outcomes if they choose the posterior approach.

Article PICO:

Population— patients with unilateral hip osteoarthrosis (osteoarthritis), ages 25-75 years

Intervention— Direct anterior approach THA, with no post-surgical hip precautions

Comparison— Posterior approach THA, with post-surgical hip precautions implemented

Outcomes— M-FIM, TUG, VAS pain scale, HHS, UCLA activity score, SF-12, length of hospital stay, narcotic consumption, discharge disposition, intraoperative and postoperative complications, operative time, reoperation frequency, radiographs

Blinding: No blinding was performed for surgeons, therapists, assessors, or subjects. Although rehabilitation was standardized for both groups, therapist influence could have played a role in how quickly subjects were able to meet functional milestones. Because many of the outcome measures were self-reported questionnaires, rater bias (due to lack of blinding of the assessors) is unlikely. The subjects were not given insight into the hypothesis of the study, minimizing threats due to lack of subject blinding.

Controls: There was not a true control group in this study; rather, both groups received surgical treatment. All subjects from both groups received the same design of prosthetic implants and the same treatment protocols post-operatively, with the exception of range of motion restrictions which were implemented for the subjects who received a posterior approach THA. It seems, therefore, that differences between groups can be attributed to the intervention.

Randomization: Subjects were not randomized to groups. Instead, subjects underwent their surgery of choice, as recommended by their surgeon. This poses a significant threat to the validity of the study; however, the two groups were similar in regard to demographics and pre-operative scores on functional measures.

Study: This is a prospective, non-randomized trial which included 132 subjects at a single institution; 67 underwent a direct anterior approach THA and 65 underwent a posterior approach THA. Subjects, along with their surgeons, chose which surgical technique to undergo. Subjects were included if they were ages 25-75 years, with a diagnosis of unilateral hip osteoarthritis (osteoarthritis) and willing to comply with protocol for study. Subjects were excluded if they were undergoing bilateral THA, if they were undergoing THA due to femoral neck fracture, and if they had history of previous open hip surgery.

Three surgeons were involved in the study, all with training primarily in the posterior approach. The surgeon who performed the direct anterior approach surgeries had obtained training and experience in this approach prior to the study.

The same femoral and acetabular component design was used for every subject, with variance in sizes used. The anterior approach used was performed with the patient supine on a standard operating table with a table mounted femoral elevator, using a C-arm x-ray machine for visualization throughout the procedure. The authors cite an

article which fully describes the technique used. Stability testing was performed in multiple positions, with leg length and socket position adjusted accordingly. The posterior approach THA was performed using a 14-16 cm skin incision. The external rotators were cut and the head of rectus femoris reflected in order to access the hip joint. The authors cite an article which fully describes the technique used. The capsule and tendons were repaired afterwards, and stability testing was performed in multiple positions with leg length and socket position adjusted accordingly.

Post-operatively, both groups participated in early rehabilitation, with weight bearing as tolerated and physical therapy beginning on the morning after surgery. Hip precautions were implemented for six weeks for those who had a posterior approach THA; they were educated in use of abduction pillow, a high chair, and no combination of greater than 90 degrees of flexion with adduction and internal rotation of the hip. Subjects received two sessions of physical therapy each day while hospitalized, and were discharged when they met the following criteria: ability to transfer to and from a chair and bed without assistance, ability to walk at least 150 feet, and ability to ascend and descend four stairs. If they did not meet the criteria, they were discharged to a skilled nursing facility. Subjects used either a walker or a pair of Lofstrand crutches during early recovery, advancing to use of a cane as tolerated. Home health and outpatient physical therapists were given instructions to standardize rehabilitation after subjects were discharged.

Outcome measures:

The HHS scores, measured preoperatively and 6 weeks and 12 months postoperatively, are relevant in answering my clinical question, along with the VAS pain rating measured 48 hours after surgery.

The HHS is a 100-point scale that assesses hip joint pain, function, range of motion, and absence of deformity, with a higher score indicating better function. It has a MCID of seven points (Achten *et al.*). The VAS is a zero to ten scale of self-reported pain. It has an MCID of 15.3 mm on a 100 mm scale in patients with hip OA (Tubach *et al.*). This is equivalent to an MCID of 1.53 cm on the ten centimeter scale used by the authors of this study.

Study losses:

The authors report that seven subjects (10.4%) were lost from the direct anterior surgery group, four who chose to drop out and three who failed to comply with follow up outcome measures in a timely fashion. Five subjects (7.7%) were lost from the posterior surgery group, one who chose to drop out and four who failed to comply with follow up outcome measures in a timely fashion.

An intention-to-treat analysis was not performed, but it does seem that all subjects were analyzed in the groups they were randomized to (it would not have been possible for a subject to change groups after undergoing the surgical procedure that was designated to him or her).

Summary of internal validity: The internal validity of this study is fair. Strengths of the study include use of an appropriate comparison group, use of valid and reliable outcome measures, recruitment of an adequate sample size based on power analysis

calculation, use of appropriate statistical tests, and implementation of a strict protocol following surgery.

One major threat and four minor threats challenge the internal validity of this study. Because subjects were not randomized to their groups, selection is a major threat to the validity. The group that chose to undergo the innovative direct anterior approach THA may have had a higher level of motivation than the group that chose to undergo the traditional posterior approach THA. Rater bias is a minor threat present in this study, due to lack of blinding of the therapists and surgeons which likely resulted in some influence on subjects' outcomes. However, the authors attempted to minimize bias by having medical staff other than the surgeons perform follow up assessments, and by having the subjects keep a diary of functional milestones. Hawthorne effect and Rosenthal effect are additional minor threats due to lack of subject blinding, as the subjects may have been influenced by the knowledge that they were in a study, even though the study hypothesis was not discussed with them. The final minor threat identified is the lack of intention-to-treat analysis, which would have taken the study losses into account in data analysis.

Evidence: Scores from the HHS measured prior to surgery and again six weeks and 12 months post-operatively were analyzed in order to address my clinical question. This data, as reported in the study, is shown in Table 8.

Table 8. Between group differences in Harris Hip Score means and SDs taken pre-operatively as well as at six weeks and 12 months post-operatively.

	Pre-operative	6 weeks	12 months
Direct anterior approach	49.4 (7.5)	83 (12)	89 (11)
Posterior approach	46.6 (11.5)	80 (11)	91 (10)
Between group difference (p-value)	0.17	0.13	0.59

As indicated by the p-values given by the authors, there were no significant differences between groups in total HHS scores at any time point measured.

Both groups made a clinically important improvement from baseline to six weeks after surgery, exceeding the MCID of seven points. The posterior approach group again made a clinically important improvement from six weeks to one year post-operatively, on average, whereas the direct anterior group did not.

Although there was this discrepancy in within-group improvements, there is no evidence to support either group as resulting in a better functional outcome at six weeks and one year post-surgery as shown by between-group analysis.

Visual analogue scale assessments taken 48 hours after surgery were also analyzed. This data given by the authors are presented in Table 9.

Table 9. Between group comparison of Visual Analogue Scale means (cm) measured 48 hours post-operatively.

	48 hours post-operative
Direct anterior approach	3.3
Posterior approach	3.5
Between group difference (p value)	0.52

Two days after surgery, all subjects from both groups rated their pain with a similar number on the VAS. The p-value indicates there was no significant difference between groups.

In conclusion, both groups made functional improvements during the first year after surgery, as indicated by HHS scores. Both groups reported a similar pain level early after surgery, as measured with the VAS. No between-group differences were of statistical significance; according to the results of this study, neither surgical approach results in better early pain or functional outcomes or long term functional outcomes.

Applicability of study results:

Benefits vs. Costs:

According to the evidence, there are no pain related or self-assessed functional benefits to receiving THA via the direct anterior approach over the conventional posterior approach. Although the authors report that the subjects in the direct anterior group performed better on early functional outcome measures, such as the ability to walk 150 feet, these outcome measures have not been validated and were subject to bias. Length of hospital stay was similar between groups. Complications occurred in both groups, with one patient from each group obtaining heterotopic ossification, one subject in the direct anterior group a non-displaced greater trochanter fracture, and one subject in the posterior group a posterior dislocation requiring cup revision. Both surgical approaches seem to have similar costs and benefits.

Feasibility of treatment:

The direct anterior approach THA is a newer technique and not as readily available as the posterior approach THA. Extensive training is required for a surgeon to become proficient in the direct anterior approach. Both surgical approaches are well described in the literature, with similar protocols used between surgeons. In terms of post-operative feasibility, posterior approach range of motion restrictions can be difficult for patients to implement. In this regards, post-operative rehabilitation protocol is more feasible for those with direct anterior approach THA, because they do not have range of motion precautions to follow.

Summary of external validity:

The external validity of this study is fair. The population used closely matches the population of patients I see clinically after THA. However, some patients were excluded, for example, those with history of prior open surgery to the hip. The results of this study cannot be applied to these patients. Because only three surgeons were involved in the study, it is difficult to extrapolate the results to a large patient population; however, the surgical techniques used were fairly standard. Finally, concerns with the internal validity of this study also limit the ability to generalize results of the study to a broader population.

Article: Yang *et al.*, 2010.

Clinical Bottom Line:

Based on this randomized, controlled trial performed by Yang *et al.*, there is strong evidence to support the minimally invasive anterolateral/OCM approach to total hip arthroplasty as providing better early pain and functional outcomes than the traditional posterolateral approach in patients with femoral neck fracture, osteonecrosis, osteoarthritis, or rheumatoid arthritis. The anterolateral group had a lower pain rating on the VAS scale the day after surgery, with a large effect size, and a higher functional score on the HHS at three months post-operatively, with a large effect size. Both groups made significant functional improvements throughout the first three years after surgery. The internal validity of this study is good, due to successful randomization, blinding, and other controls used. However, study losses are not accounted for, and extraneous variables likely played a role in subjects' functional improvement during the three year follow up. External validity is a large concern with this study, because it was performed in China and surgical and post-surgical procedures differed dramatically from those used for my patients in the U.S. No hip precautions were implemented for the posterolateral surgical group. The early post-operative benefits of receiving a minimally invasive anterolateral approach THA do outweigh the costs, and I would likely recommend this option to my patients over a posterior or posterolateral approach THA, in spite of validity concerns with the study.

Article PICO:

Population— patients who presented for unilateral THA with a diagnosis of femoral neck fracture, osteonecrosis, osteoarthritis, or rheumatoid arthritis

Intervention— THA using minimally invasive surgery (MIS), anterolateral approach

Comparison— THA using conventional posterolateral approach

Outcomes— HHS, Barthel index questionnaire, VAS pain scale, operation time, incision length, blood loss, blood transfusion, radiograph analysis, incidence of complications

Blinding: Although it was impossible to blind the surgeons to the group designation, the subjects and therapists were blinded during the hospitalization period by use of a standard dressing that obscured the site of incision. The assessor of radiographic outcomes was also blinded. Although not discussed by the authors, subject blinding could not have been maintained during follow up period of three years. Still, this is unlikely to have affected outcomes and is not a significant threat to the validity of the study.

Controls: There was not a true control group in this study; rather, a comparison group was used. Both groups received THA, with a similar pain medication regimen and

postoperative rehabilitation used. Because of this standardization between groups, it is likely that between group differences can be attributed to the intervention.

Randomization: Subjects were randomized into groups using a simple randomization technique which was concealed. The randomization was successful, with no significant differences between groups in demographics or baseline scores on the HHS, Barthel index, or ASA grade.

Study: This randomized, controlled trial involved 110 subjects, 55 who underwent a minimally invasive anterolateral/OCM approach THA and 55 a posterolateral approach THA. Subjects had a diagnosis of femoral neck fracture, osteonecrosis, osteoarthritis, or rheumatoid arthritis, with indication for unilateral THA. Subjects were excluded if they had a history of prior surgery on the same hip, severe inflammatory polyarthritis limiting mobility, pulmonary and heart insufficiency, cerebrovascular diseases with physical sequelae, body mass index greater than 30, and developmental dysplasia of the hip, Crowe III-IV. Although an age range is not reported, the average age of subjects in the anterolateral group was 59.47 years and 55.82 years in the posterolateral approach group.

All surgeries were performed by a single surgeon who had previous experience performing several different surgical approaches, with the OCM/anterolateral approach being the newest approach he or she had used. The anterolateral approach was performed with subjects side-lying on a Jupiter Table with pelvis and torso stabilized. The incision of approximately 7 cm was made over the greater trochanter area, and the hip was exposed through a separation of tensor fasciae latae and gluteus medius muscles, as well as opening of the anterior capsule. The authors describe the details of the procedure, including prostheses installation and the use of x-rays to check positioning. The posterolateral approach that was used is not well-described, but was performed with an incision of approximately 15 cm and involved incision of part of gluteus maximus as well as the external rotators of the hip. All subjects received similar medications after surgery and a standard length dressing over the incision. A set protocol was used for rehabilitation, with all subjects mobilized with full weight-bearing on the third day. No post-operative range of motion restrictions were implemented for either group.

Outcome measures:

The HHS and VAS scores were the outcomes most relevant to answering my clinical question. The HHS scores were measured pre-operatively, three months after surgery, and three years after surgery. The VAS scores were measured the day after surgery. Although the authors did not report reliability, both of these outcome tools are valid and reliable, according to Kaczmarek *et al.* The HHS is a 100-point scale that assesses hip joint pain, function, range of motion, and absence of deformity, with a higher score indicating better function. It has a MCID of seven points (Achten *et al.*).

The VAS is a zero to one hundred millimeter scale of self-reported pain. It has an MCID of 15.3 mm in patients with hip OA (Tubach *et al.*).

Study losses: The authors did not discuss study losses, and it is difficult to tell from the data presented whether all subjects are accounted for. No statement is made regarding an intention-to-treat analysis. It does seem, however, that all subjects were analyzed in the groups they were randomized to (it would not have been possible for a subject to change groups after undergoing the designated surgical procedure).

Summary of internal validity: The internal validity of this study is good. Subjects were successfully randomized to groups, therapists and subjects were blinded to surgical approach during early post-surgical period, valid and reliable outcome measures were used, and appropriate statistical tests were performed. These strengths of the study control against many possible threats to the validity. However, two major threats and one minor threat were identified. The authors did not address any study losses, or mention of an intention-to-treat analysis. In the three years after surgery, it is likely that some of the subjects did not complete outcome measures at all follow up points; however it is not stated how this was managed in data analysis. Extraneous variables are also a major threat, because the protocol for post-surgical rehabilitation was not well described. It is unclear whether subjects were referred to outpatient physical therapy after discharge from the hospital and whether they were allowed to seek out further treatment for hip pain in the three years after surgery, implying that some patients may have received more treatment/therapy than others. The minor threat to the internal validity is the potential for inadequate power, since the authors did not report a power analysis and sample size calculation. Because the sample size seems to be adequately large, this is only a minor threat.

Evidence: The VAS scores recorded the day after surgery were analyzed, as well as the HHS scores taken before surgery and three months and three years after surgery, in order to address my clinical question.

Table 10. Between group comparison of Visual Analogue Scale means (mm) and SDs, measured post-operatively on the day after surgery.

	Day after surgery
MIS anterolateral approach	30.76 (21.77)
Posterolateral approach	50.34 (13.73)
Between group difference (p value)	<0.01
Effect size (95% CI)	1.08 (0.68 to 1.48)

The group who had received MIS anterolateral THA reported significantly less pain on the day after surgery than the group who received posterolateral THA. A large effect size of 1.08 confirms that the anterolateral surgical procedure resulted in an improved pain level the day after surgery, in comparison to the posterolateral approach surgery. It is also important to note that, although the same pain medications were administered for both groups, subjects received a patient-controlled analgesia (PCA) with fentanyl citrate, and no data is reported regarding how often subjects from each group chose to use this. This medication likely had a significant effect on the subjects' perception of their pain on the day after surgery.

Because VAS scores were not reported at any other time point, it is impossible to determine whether either group made a clinically important improvement in pain level over time.

Table 11. Between group differences in Harris Hip Score means and SDs taken pre-operatively as well as three months and three years post-operatively.

	Pre-operative	3 months	3 years
MIS Antero-lateral approach	25.93 (11.3)	83.80 (5.64)	91.20 (5.38)
Posterolateral approach	28.18 (13.73)	74.96 (7.47)	91.64 (4.81)
Between group difference (p-value)	0.35	<0.01	0.66

Both groups started with a low score on the HHS, on average, indicating poor function. Three months after surgery, the group who received anterolateral approach THA scored significantly higher ($p < 0.01$) than the group who received posterolateral approach THA. Both groups had similar HHS scores at the three year follow up point. Effect size calculations were performed with this data, and are presented below.

Table 12. Effect size and 95% confidence intervals for HHS measures in MIS anterolateral approach and posterolateral approach THA at three months and three years post-operative.

	3 months post-surgery	3 years post-surgery
Effect size	1.34 (0.92 to 1.75)	0.09 (-0.29 to 0.46)

A large effect size of 1.34 favors the MIS anterolateral group three months after surgery. This indicates that the anterolateral surgery technique had a large effect on early functional improvements in comparison to the posterolateral surgery.

Within group analysis of the data reveals that clinically important improvements were achieved in both groups, between each time point measured, exceeding the MCID of seven points.

In conclusion, minimally invasive anterolateral approach THA resulted in a lower self-reported pain level the day after surgery, with a large effect size of 1.08, and a higher self-reported functional level three months after surgery, with a large effect size of 1.34. Both groups made similar functional improvements during the three years after surgery, with no long-term differences noted between groups.

Applicability of study results:

Benefits vs. Costs:

The benefits of receiving THA via the minimally invasive anterolateral approach over the conventional posterolateral approach include earlier functional gains and lower pain

level after surgery, according to this study. Other benefits included a shorter incision length (average of 7.49 cm in comparison to 15.19 cm), and significantly less blood loss. Operation time was similar between groups. Three subjects from the posterolateral group incurred heterotopic ossification, with no other complications in either group. The early benefits of choosing a minimally invasive anterolateral approach THA over the traditional posterolateral approach seem to outweigh the costs.

Feasibility of treatment:

Although the minimally invasive anterolateral surgical technique was described in great detail, the authors did not describe the conventional posterolateral technique and therefore it would be difficult to reproduce. Also, because the study took place in China, surgical techniques and post-surgical protocols are very different than those used in the United States. For example, average operation time was less than 80 minutes for both groups in this study, whereas operation time for a THA at the hospital where I am working is two to three hours. Patients in this study were not encouraged to ambulate with weight bearing on the operative lower extremity until the third day after surgery, whereas protocol in my hospital is to begin this on either the day of surgery or early the following day. No posterior hip precautions were implemented, as they would be for my patients who undergo a posterolateral approach THA. Therefore, the feasibility of this study is poor.

Summary of external validity:

The external validity of this study is poor. The majority of subjects in this study had a diagnosis of femoral neck fracture or osteonecrosis, whereas most of my patients who undergo a THA have a diagnosis of osteoarthritis. Some of my patients have had previous hip surgery, or have a BMI of greater than 30; however, subjects with those conditions were excluded from the study. The average age of the subjects was also younger than the average age of my patients. Additionally, this study was performed in China, with all surgeries performed by a single surgeon, using surgical and post-surgical protocols that differ from ours. This makes it is very difficult to extrapolate the study results to patient populations who undergo THA in the U.S.

Article: Taunton *et al.*, 2014.

Clinical Bottom Line: Patients with primary degenerative arthritis of the hip will have similar improvements in pain and function after a total hip arthroplasty performed via the direct anterior approach or the mini-posterior approach, based on evidence from a randomized, controlled trial performed by Taunton *et al.* Results from the HHS and WOMAC outcome measures found that subjects who underwent either procedure made significant improvements, with most subjects achieving a complete resolution of pain by one year after surgery. The two groups were treated with a similar rehabilitation protocol after surgery; however, post-operative range of motion restrictions were implemented for subjects in the posterior group. The internal validity of this study is good, with many controls used; however, some concerns are apparent due to lack of blinding (rater bias may have influenced subjects' responses), small sample size (with a risk of type II errors), and potential for extraneous variables during the year after surgery. Many types

of patients were excluded from involvement in this study, limiting my ability to generalize the results to all of my patients. Although a cost-benefit analysis does not favor one approach over the other, the anterior approach allows the patient to return to normal activities without range of motion restrictions. Therefore, I am likely to recommend this anterior approach to my patients, even though they may achieve similar pain and functional outcomes with the posterior approach.

Article PICO:

Population— patients age 25-80 years, diagnosed with degenerative arthritis of the hip and electing to undergo THA

Intervention— Direct anterior approach THA, with no post-operative range of motion restrictions

Comparison— Mini-Posterior approach THA, with range of motion restrictions post-operatively

Outcomes— number of days post-operatively to achieve functional milestones (discontinued use of assistive device for ambulation, discontinued need for assistance with activities of daily living, return to work, discontinued narcotic pain medications, ability to ascend and descend stairs, ability to walk half a mile), scores on self-reported functional outcome questionnaires (HHS, WOMAC, SF-12), and radiographic outcomes (leg length discrepancy, implant position)

Blinding: Surgeons and physical therapists were not blinded due to the nature of the study (the surgical techniques and post-surgical precautions were markedly different between groups). Lack of blinding of the therapists is a significant threat because of bias that may have been present. Although early rehabilitation was standardized for both groups, therapist influence could have played a role in how quickly subjects were able to meet functional milestones. Subjects were initially blinded, prior to surgery, and were informed that both surgical techniques are successful, with no information about the hypothesis of the study given. This minimizes the threat due to lack of subject blinding. The assessors for radiographic outcomes were blinded; however, no statement is made regarding blinding of the assessors for other outcome measures. Given the nature of the self-reported questionnaires, potential for rater bias is low in administering these outcome measures.

Controls: There was not a true control group in this study; rather, both groups received surgical treatment. All subjects from both groups received the same prosthetic implants and the same treatment protocols post-operatively, with the exception of range of motion restrictions which were implemented for the subjects who received a posterior approach THA. It seems, therefore, that differences between groups can be attributed to the intervention.

Randomization: Subjects were randomized to their groups according to stratification by age and gender, which was appropriate in regards to demographics. However, the group receiving the direct anterior approach THA had a higher pain score on the WOMAC prior to surgery, with a p-value approaching significance (0.051). This is a minor issue, because it is the treatment group of interest that started out with a worse pain status.

Study: This randomized, controlled trial involved 54 subjects, 27 who underwent a direct anterior approach THA and 27 a mini-posterior approach THA. All subjects met inclusion criteria of age 25-80 years, with primary degenerative arthritis of the hip. They had each elected to undergo THA, and were willing to comply with study requirements. Patients were excluded if they had undergone previous THA, or if they had inflammatory arthritis, osteomyelitis, previous intra-articular infection, severe developmental dysplasia of the hip, metal allergy, Charcot arthropathy, Paget's disease, chronic narcotic dependence, offset greater than 50 mm, or acetabular deformity that would require advanced reconstructive techniques.

All surgeries were performed by a single surgeon who performed the direct anterior approach most often in practice outside of this study. The same femoral and acetabular component design was used for every subject. The anterior approach used was performed with the patient supine on an orthopedic table, with an oblique 10 cm incision made and access to the hip joint obtained between the tensor fasciae latae and sartorius muscles. Fluoroscopy was used throughout the procedure, to aid in appropriate positioning of the prosthesis after removal of the femoral head and reaming of the acetabulum. Subjects who received the mini-posterior approach THA were placed in the lateral decubitus position, with a 10 cm incision over the greater trochanter area of the hip and incision of the external rotators and posterior capsule to access the hip joint. After dislocation, resection at the neck of the femur, and implantation of the prosthetic components, the hip capsule was re-attached to the greater trochanter. Post-operatively, both groups participated in early rehabilitation, which included ambulation the first day after surgery and two sessions of physical therapy each day while hospitalized. Range of motion restrictions (90 degrees of hip flexion, and adduction beyond neutral) were implemented for those who had a posterior approach THA. Patients were discharged when they were able to transfer in and out of bed with minimal assistance, ambulate 100 feet with assistive device, ascend and descend three stairs, and control pain level with oral medications.

Outcome measures: The outcome measures that are relevant in answering my clinical question are the HHS and the WOMAC. These measures were taken pre-operatively and again three weeks, six weeks, and one year after surgery. Although the authors did not report reliability, both of these outcome tools are valid and reliable, according to Kaczmarek *et al.* The HHS is a 100-point scale that assesses hip joint pain, function, range of motion, and absence of deformity, with a higher score indicating better function. It has a MCID of seven points (Achten *et al.*). The WOMAC includes 24 questions and consists of three subsections: pain, joint stiffness, and physical function. It is scored 0-100 with higher scores indicating better results. The MCIDs for the pain,

function, and stiffness sections of the WOMAC are 9.7, 9.3, and 10.0, respectively (Ehrich *et al.*).

Study losses: There were no subjects lost to follow up, and all subjects were analyzed according to the group they had been randomly assigned to.

Summary of internal validity: The internal validity of this study is good. Subjects were successfully randomized to groups, valid and reliable outcome measures were used, and appropriate statistical tests were performed. The authors imply that an intention to treat analysis was performed, and protocol was fairly strict. These strengths of the study control against many possible threats to the validity. However, there is one major threat and three minor threats to the study's internal validity. Rater bias is inevitable, considering the lack of surgeon and therapist blinding. This is a major threat because of the influence these individuals likely had on the subjects' outcomes. Presence of extraneous variables is a minor threat, because the subjects may have received additional treatment in the year following surgery that is not controlled for. This is only a minor threat because the authors do describe specific, early rehabilitation protocol which all subjects adhered to, and each subject kept a diary to record their achievement of functional milestones. Another potential minor threat is inadequate power. The authors describe calculation of a sample size estimate, but do not state what power they were achieving with their seemingly small sample size of 54 subjects. Hawthorne effect is the final threat identified; because subjects were not blinded, their outcomes may have been influenced by the knowledge that they were in a study.

Evidence: Scores from the HHS and WOMAC pain and function subsections measured at three weeks, six weeks, and 12 months post-operatively were analyzed in order to address my clinical question. Because the data were presented by the authors as ranked data, it was not possible to calculate effect sizes.

Table 13. Between group differences in Harris Hip Score medians and interquartile ranges taken pre-operatively as well as at three weeks, six weeks and 12 months post-operatively.

	Pre-operative	3 weeks	6 weeks	12 months
Direct anterior approach	55 (46-63)	86.5 (77-95)	97(90-98)	98 (94-100)
Posterior approach	51 (45-69)	81 (74-89)	93 (89-98)	97.5 (87-100)
Between group difference (p-value)	0.497	0.085	0.135	0.231

A ceiling effect occurred, according to the means which near 100 for both groups at the 12 month follow up. No significant differences exist between groups.

Within group analysis reveals that both groups made clinically important improvements, exceeding the MCID of seven points, from baseline to three weeks post-operative, and again from three to six weeks post-operatively.

Table 14. Between group differences in WOMAC pain subscale medians and interquartile ranges taken pre-operatively as well as at three weeks, six weeks and 12 months post-operatively.

	Pre-operative	3 weeks	6 weeks	12 months
Direct anterior approach	45.0 (40-60)	97.5 (80-100)	100 (90-100)	100 (95-100)
Posterior approach	55.00 (40-65)	100 (85-100)	100 (100-100)	100 (95-100)
Between group difference (p-value)	0.051	0.294	0.111	0.364

As previously discussed, the subjects who underwent posterior approach THA had a higher pain score at baseline. No significant difference between groups is noted at further follow up points.

Both groups made clinically important improvements in pain levels from baseline to three weeks post-operatively, exceeding the MCID of 9.7. After three weeks, subjects tended to have complete resolution of pain, with a ceiling effect noted. This was maintained through the one year follow up.

Table 15. Between group differences in WOMAC function subscale medians and interquartile ranges taken pre-operatively as well as at three weeks, six weeks and 12 months post-operatively.

	Pre-operative	3 weeks	6 weeks	12 months
Direct anterior approach	50 (30.88-58.82)	86.76 (75-92.65)	97.06 (88.24-98.53)	98.53 (95.59-100)
Posterior approach	48.53 (36.76-58.82)	91.18 (83.82-94.12)	97.06 (92.65-100)	98.53 (89.71-100)
Between group difference (p-value)	0.478	0.056	0.392	0.430

No significant differences exist between groups at any follow up point; however, the posterior group demonstrated a tendency towards better function three weeks after surgery, with a p-value approaching significance ($p=0.056$). A ceiling effect is noted for both groups, as averages near a score of 100 at the 12 month follow up.

Both groups made clinically important improvements in function from baseline to three weeks post-operatively, exceeding the MCID of 9.3. Subjects in the direct anterior group again met the MCID for improvement from three to six weeks, on average.

In conclusion, there is no evidence to support either the direct anterior approach or the mini-posterior approach as resulting in better pain or functional outcomes, either early post-operatively or at a one year follow up. Results from HHS and WOMAC outcomes were conflicting, with the direct anterior approach group tending to show better HHS scores three weeks after surgery, and the mini-posterior group tending to show better WOMAC function scores at the same follow up point. Both groups made clinically important improvements on all outcome measures analyzed.

Applicability of study results:

Benefits vs. Costs:

According to the evidence, there are no pain related or self-assessed functional benefits to receiving THA via the direct anterior approach over the mini-posterior approach. Although the authors reported that the subjects in the direct anterior group attained functional milestones, such as discontinuation of walking aids, earlier than the mini-posterior group, these outcome measures were subjective and subject to bias. Complications occurred in both groups, including two calcar cracks occurring during the anterior approach surgeries, and one in the posterior approach. Costs and benefits seem to be similar for each surgical approach.

Feasibility of treatment:

The direct anterior approach THA is a newer technique and not as readily available as the posterior approach THA. Extensive training is required for a surgeon to become proficient in the direct anterior approach. Both surgical approaches are well described in the literature, with similar protocols used between surgeons. In terms of post-operative feasibility, posterior approach range of motion restrictions can be difficult for patients to implement. In this regards, post-operative rehabilitation protocol is more feasible for those with direct anterior approach THA, because they do not have range of motion precautions to follow.

Summary of external validity:

The external validity of this study is fair, with a population that is fairly similar to the patients I see in the hospital/clinic. However, patients were excluded from the study for a variety of reasons. The results of this study cannot be applied to those who have had a previous THA, for example, because they were excluded from the study. Also, because the study was performed at a single institution and all surgeries were performed by a single surgeon, it is difficult to extrapolate the study results to a wider population, including my patients.

Synthesis/Discussion

In summary, both anterior and posterior approaches to THA tend to result in positive outcomes with regards to self-reported pain and function. There is some evidence to indicate that the anterior approach produces better pain levels and function early after surgery; however, the validity of the research is questionable. Ranking of methodological quality of each study was performed with the PEDro scale, with scores of 6, 4, 9, and 6 for the studies by Barrett *et al.*, Rodriguez *et al.*, Yang *et al.* and Taunton *et al.*, respectively. The study by Rodriguez *et al.* was a non-randomized trial, resulting in a lower quality of research because subjects were able to choose their group. Blinding of subjects and therapists was not achieved in three of the four studies. This could have resulted in different motivation levels based on subjects' and therapists' expectations of which group would perform better after surgery. Another significant threat to internal validity of these studies was lack of strict protocol throughout study period. None of the authors described rehabilitation standards after discharge from the hospital, and it is likely that some subjects sought out more physical therapy than others

during the follow up periods. An additional threat to validity that was present in the Barrett *et al.* and Yang *et al.* articles was a failure to account for study losses. Although it is unlikely that all subjects responded to all follow-ups over the course of one to three years, there is no description of how study losses were managed in data analysis. The article by Yang *et al.* demonstrated the best methodological quality as well as the strongest evidence favoring an anterolateral approach; however, the feasibility and external validity of this study were poor because it was performed out of the country. The surgical procedures and rehabilitation used were very different than those used for my patients.

Table 16 summarizes the validity grades of each study as well as the evidence found.

Table 16. Summary of internal validity, evidence, and external validity for articles.

	Barrett <i>et al.</i>	Rodriguez <i>et al.</i>	Yang <i>et al.</i>	Taunton <i>et al.</i>
Internal validity	Fair	Fair	Good	Good
External validity	Fair	Fair	Poor	Fair
Evidence – statistical significance between groups	Direct anterior group – less pain 1 st day post-op, better function 6 weeks post-op	No difference between groups in pain or function at any follow up points	Anterolateral group – less pain 1 st day post-op, better function at 3 months post-op	No difference between groups in pain or function at any follow up points

Surgical procedures used in each study differed in incision lengths, prosthetic components used, type of surgical table used, and other variables. Each study was performed at only one facility, with one to three surgeons performing operations in each study. This makes it difficult to apply the results to a larger population.

A variety of patient populations were represented in these four studies, including a large age range and a diagnosis of osteoarthritis for the majority of subjects. Yang *et al.*, did include patients with femoral fracture, osteonecrosis, and rheumatoid arthritis, with average functional scores much lower at baseline.

Based on the available evidence from Barrett *et al.*, Rodriguez *et al.*, Yang *et al.* and Taunton *et al.*, subjects may have better early pain and functional outcomes after an anterior approach THA as opposed to a posterior approach THA. However, evidence is conflicting as some studies reveal that posterior approach THA results in similar outcomes both early after surgery and up to one year later. One of the benefits to the anterior approach is the lack of hip precautions, which may contribute to subjects' faster recovery and is a primary reason that I am likely to recommend this approach to my patients.

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